

*Trypanosome Diseases of Domestic Animals in Uganda.*

## I. Trypanosoma Pecorum.

By Colonel SIR DAVID BRUCE, C.B., F.R.S., Army Medical Service; Captains A. E. HAMERTON, D.S.O., and H. R. BATEMAN, Royal Army Medical Corps; and Captain F. P. MACKIE, Indian Medical Service. (Sleeping Sickness Commission of the Royal Society, 1908-9.)

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[PLATES 11 AND 12.]

## SYNONYMS.

*Trypanosoma dimorphon* (Dutton and Todd).

*Trypanosoma congolense* (Broden).

*Trypanosoma confusum* (Montgomery and Kinghorn).

Dr. Edington's trypanosome from Zanzibar (Bruce, Hamerton, and Bateman).

Trypanosome from Chai-Chai, Zambezi, Zululand (Theiler).

Trypanosome from Southern Rhodesia (Bevan).

## INTRODUCTION.

As might be expected from the tropical nature of the country, Uganda suffers much from protozoal diseases, and as the wealth of the natives consists principally in cattle, goats, and sheep—the King and chiefs having huge herds—there is much loss.

To give an idea of the enormous mortality which must take place among the herds of cattle in Uganda, Sir Apolo Kagwa, K.C.M.G., the Prime Minister, may be quoted. He informed the Commission that during 1908 he had 1396 cows, which had 2021 calves, and of these calves 709 died—35 per cent. Further, of cows, bulls, and full-grown bullocks, there had died 351. This makes a total of 1060 deaths in one year. The number of the whole herd is not given, but may be put down at 4000. This means a yearly death-roll of about 25 per cent. During the same year the Government Transport Department in Entebbe lost 156 oxen between June and November.

During 1909 the Commission had the opportunity of investigating several outbreaks of trypanosome disease among domestic animals, one among the transport cattle at Entebbe (lat.  $0^{\circ} 3'$  N., long.  $32^{\circ} 30'$  E.); another at Kampala (lat.  $0^{\circ} 18'$  N., long.  $32^{\circ} 35'$  E.); a third at the Uganda Company's estate at Namukekera (lat.  $0^{\circ} 40'$  N., long.  $32^{\circ} 17'$  E.); a fourth at Mr. Walsh's farm at Kabula Muliro, a few miles west of Namukekera; and a fifth at the Mabira Rubber Estate (lat.  $1^{\circ} 50'$  N., long.  $32^{\circ} 40'$  E.).

The commonest trypanosome disease among cattle in Uganda is caused by a trypanosome of the *dimorphon* type, which it is proposed to call *Trypanosoma pecorum*. This species is probably the same as that which has been known by the name *Trypanosoma dimorphon* (Dutton and Todd), and is either identical with, or very similar to, Broden's *Trypanosoma congolense*. The name *dimorphon* is a misleading one, and can only be accounted for by Dutton and Todd describing under one name two species of trypanosomes occurring in the same animal. No one, so far as we are aware, has re-discovered Dutton and Todd's *Trypanosoma dimorphon*, although many attempts to reconcile later observations with theirs have been made. Certainly the strain kept at the Liverpool School of Tropical Medicine under that name does not agree with the original description. The term *Trypanosoma dimorphon* must therefore disappear, since it was born of a misapprehension. But it will at once be said, if the name *Trypanosoma dimorphon* must go, why not call the species *Trypanosoma congolense*? The only reasons that can be given are, that *Trypanosoma congolense* is a local name and, therefore, not very suitable, and secondly, that if it comes to strict priority, then *Trypanosoma dimorphon* holds the field in spite of its misleading character and the error its authors fell into, because it cannot be denied that there is a strong feeling that *Trypanosoma dimorphon* and *Trypanosoma congolense* are one. At the same time it must also be granted that there are others who are strongly of opinion that *Trypanosoma dimorphon* and *Trypanosoma congolense* are distinct species. Under these circumstances it seems best to unite the old names under a new one, and *Trypanosoma pecorum* seems appropriate enough, as this trypanosome disease is peculiarly one of herds. Montgomery and Kinghorn have lately proposed the name *confusum*, in order to get out of the difficulty; but this name has been used for a trypanosome already, and it is, moreover, an awkward term.

It must then be understood that in the species *Trypanosoma pecorum* we include *Trypanosoma dimorphon*, *Trypanosoma congolense*, the trypanosome discovered in Zanzibar by Edington and described in the 'Proceedings,'\* that from Portuguese East Africa and Zululand described by Theiler, and the species found in Northern Rhodesia by Montgomery and Kinghorn, and in Southern Rhodesia by Bevan.

The other species of trypanosomes found in the blood of cattle in Uganda were *Trypanosoma gambiense*, *Trypanosoma brucei*, *Trypanosoma vivax*, *Trypanosoma cauzalboui*, and *Trypanosoma nanum*. These names, however, may require to be reconsidered.

\* B, vol. 81, p. 14.

## DISTRIBUTION IN UGANDA.

Cattle suffering from *Trypanosoma pecorum* were sent to the Sleeping Sickness Commission's laboratory at Mpumu from Entebbe, Kampala, Namukekera, Kabula Muliro, and Mabira. It is probably widely distributed throughout Uganda. It was also found in a horse which had arrived in Nairobi, British East Africa, from Abyssinia. The Commission is indebted to Mr. Stordy, Principal Veterinary Officer, for the opportunity of studying this trypanosome. It is not known where the horse became infected, but it must have been at some point between Nairobi and the Abyssinian border.

## MORPHOLOGY OF TRYpanosoma PECORUM.

## A. Living, Unstained.

This trypanosome, when observed in a preparation of fresh blood, is seen to remain at or near the same spot in the field, that is to say, it is non-translatory. It is, however, active and restless, the body quivering rapidly, and the undulating membrane and flagellum keeping up a constant vibratory motion. As a rule, it moves with the flagellar end in front. The contents of the cell are homogeneous, except for a vacuole at the posterior extremity.

A marked characteristic of this species is that it exhibits alternating periods of quiescence and activity. When quiescent it is usually invisible, as it has a habit of burying itself under small collections of red blood corpuscles.

## B. Fixed and Stained.

*Method of Staining.*—Giemsa's method, as described in a former paper,\* was used.

*Length.*—The same method of measuring was used as described in the same paper (p. 17).

*Breadth.*—Without the undulating membrane the average is about 2 microns, with the membrane about 3 microns.

*Shape.*—This trypanosome when stained is short and stout in form. The posterior extremity is blunt, or rounded, or pointed and angular. The anterior end is narrower. The undulating membrane is fairly well developed, more so, perhaps, than in *Trypanosoma nanum*. The flagellum arises near the micronucleus, and passes along the edge of the undulating membrane. There is no free flagellum.

*Contents of Cell.*—Generally homogeneous. Sometimes granules are seen which take on a chromatin stain, and are situated anterior to the nucleus.

*Nucleus.*—Is oval in shape, and situated about the middle of the body.

\* 'Roy. Soc. Proc.,' B, vol. 81, p. 16.

Table I.—*Trypanosoma pecorum*.

No. of experiment.	Animal.	Day of disease.	Method of fixing and staining.	In microns.		
				Average length.	Maximum length.	Minimum length.
82	Ox	—	Osmic vapour and Giemsa	11·7	14·0	10·0
505	"	42	"	12·3	15·0	10·0
	"	—	"	13·2	15·0	11·0
593	Sheep	50	"	14·5	17·0	10·0
44	Monkey	31	"	12·2	14·0	10·0
559		14	"	12·7	16·0	11·0
461	Dog	44	"	15·3	18·0	13·0
543	"	10	"	14·3	16·0	11·0
1406	"	31	"	13·7	16·0	11·0
551	Rat	19	"	12·6	18·0	8·0
626	"	—	"	12·8	15·0	10·0
398	Mouse	28	"	14·6	16·0	13·0
398	"	36	"	13·1	17·0	10·0
Average .....				13·3	16·0	10·6

*Micronucleus*.—Small and round, and situated near to, but not at, the posterior extremity.

*Undulating Membrane*.—Is simple, but fairly well developed.

*Flagellum*.—There is no free flagellum. In very rare cases, where there is an appearance of a free flagellum, the trypanosome will be found to be dividing.

As it is difficult to gain an idea of the general appearance of a trypanosome, a series of coloured drawings by Lady Bruce, R.R.C., is also given to supplement the written description (Plate 11). The trypanosomes have been stained by Giemsa's method, and drawn at a magnification of 2000. By referring to them, the shape, disposition of the micronucleus, and other parts of the structure of *Trypanosoma pecorum*, will be more readily understood.

As will be seen from this tabulated statement, the disease set up in domestic animals by *Trypanosoma pecorum* is a serious and fatal one.

Cattle, goats, sheep, monkeys, dogs, rats, and mice are susceptible. Guinea-pigs, on the other hand, are refractory. Horses, mules, donkeys, and rabbits were not available at Mpumu, so that, unfortunately, it is not possible to say whether they are inoculable or not. In regard to guinea-pigs it would be interesting to know whether a series of inoculations into rats or rabbits would make the *Trypanosoma pecorum* also pathogenic for them.

ANIMALS SUSCEPTIBLE TO *TRYPANOSOMA PECORUM*.

Table II.

No. of experiment.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
Cattle.				
82	Natural infection	?	2	Died 2 days after arrival.
110	"	?	243	Treated with lithium antimony tartrate.
230	"	?	4	Died 4 days after arrival.
357	"	?	3	" 3 "
358	"	?	1	" 1 day after arrival.
359	"	?	60	Treated with arsacetin.
360	"	?	14	Died of <i>Trypanosoma pecorum</i> .
391	"	?	313	
475	"	?	9	Died " 9 days after arrival.
476	"	?	2	" 2 "
477	"	?	13	" 13 "
482	"	?	5	" 5 "
483	"	?	34	" 34 "
505	"	?	265	Killed.
550	"	?	—	Treated with arsenic; still alive after 254 days.
1459	"	?	43	Died 43 days after arrival.
1560	"	?	46	46 "
1731	"	?	79	Killed.
1733	"	?	76	Died 76 days after arrival.
1735	"	?	79	Killed.
1736	"	?	79	
1737	"	?	84	Died of <i>Trypanosoma pecorum</i> .
97	Ox	9	46	
447	"	8	287	Killed."
1463	"	7	35	Died of <i>Trypanosoma pecorum</i> .
1464	"	7	14	
1225	Monkey	—	—	Died 8 days after inoculation; bitten by snake. Never showed trypanosomes.
1357	Dog	6	15	Died of <i>Trypanosoma pecorum</i> .
1358	"	6	18	" "
1359	"	6	22	" "
1363	"	6	15	" "
1364	"	6	38	" "
1365	"	6	29	" "
Average.....		6.7	63	
Goat.				
1005	Ox	—	—	Never showed trypanosomes; still alive after 72 days.
1006	"	14	44	Cause of death doubtful.
1404	"	9	41	
1405	"	—	—	Never " showed trypanosomes; under observation 31 days.
633	Monkey	12	51	Cause of death doubtful.
Average.....		11.6	45	

\* Duration includes the days of incubation, it dates from the day of infection.

Table II—*continued.*

No. of experiment.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
Sheep.				
697	Ox	21	—	Still alive after 170 days.
632	Monkey	8	43	Cause of death doubtful.
593	Dog	19	168	Died of <i>Trypanosoma pecorum</i> .
	Average.....	16	105	
Monkey.				
44	Ox	14	35	Died of <i>Trypanosoma pecorum</i> .
49	"	10	16	" "
376	"	11	56	" "
683	"	10	61	
1740	"	11	—	Still alive after 45 days.
719	Sheep	21	—	216 "
350	Monkey	10	181	Died of <i>Trypanosoma pecorum</i> .
459	"	6	80	" "
1000	"	16	45	
460	Dog	11	75	Killed for cultivation experiments.
559	"	12	39	Died of <i>Trypanosoma pecorum</i> .
560	"	14	32	" "
581	Rat	13	86	" "
	Average.....	12.3	64	
Dog.				
543	Horse	9	26	Died of <i>Trypanosoma pecorum</i> .
148	Ox	10	46	" "
349	"	22	98	
552	"	—	—	Re-injected after 17 days.
1007	"	—	—	Found dead after 14 days.
1406	"	21	29	Killed.
1407	"	—	—	Died; under observation 31 days.
1193	Monkey	8	16	Died of <i>Trypanosoma pecorum</i> .
433	Dog	7	44	" "
434	"	9	58	" "
461	"	6	40	" "
1544	"	10	21	
552	Rat	—	—	Still alive after 49 days.
	Average.....	11.3	42	
Guinea-pig.				
685	Ox	—	—	Still alive after 96 days.
1162	"	—	—	" 36 "
1163	"	—	—	" 36 "
1164	"	—	—	" 36 "
1647	"	—	—	Died; under observation 29 days.
628	Monkey	—	—	Still alive after 104 days.
1002	"	—	—	" 50 "
566	Dog	—	—	" 78 "

\* Duration includes the days of incubation, it dates from the day of infection.

Table II—*continued.*

No. of experiment.	Source of virus.	Period of incubation, in days.	Duration of disease, in days.*	Remarks.
White rat.				
397	Ox	17	39	Died of <i>Trypanosoma pecorum</i> .
551	"	16	18	Killed for cultivation experiments.
684	"	16	32	Died of <i>Trypanosoma pecorum</i> .
699	"	—	—	Experiment stopped after 57 days.
1646	"	12	16	Died of <i>Trypanosoma pecorum</i> .
626	Monkey	12	22	Killed for cultivation experiments.
1001	"	13	23	Died of <i>Trypanosoma pecorum</i> .
455	Rat	9	12	" "
729	"	11	21	" "
1708	"	8	12	" "
Average.....		12·6	21	
Mouse.				
686	Ox	—	—	Experiment stopped after 59 days.
398	Monkey	26	41	Died of <i>Trypanosoma pecorum</i> .
627	"	12	23	" "
454	Mouse	6	12	" "
Average.....		14·7	26	

\* Duration includes the days of incubation, it dates from the day of infection.

Theiler describes a trypanosome from Chai-Chai, near the mouth of the Limpopo, in Portuguese East Africa; from the mouth of the Zambesi; and also from Zululand, which resembles the one under discussion, in not infecting guinea-pigs; and considers that this one fact is sufficient for the creation of a new species. We cannot agree with him in this, as there is no practical importance, except in the laboratory, in the fact that the guinea-pig is insusceptible; and, moreover, until more experiments have been made, we cannot be sure that under certain conditions of dosage or passage through the smaller animals the guinea-pig will remain refractory.

The important facts in regard to this species are, that man is not susceptible, but that the valuable domestic animals are, and that in these animals the disease is, as a rule, a fatal one.

As long as our knowledge of trypanosomes is limited it seems better to group them under as few names as possible. As knowledge grows, and as fundamental differences emerge, then it will be time to define them more strictly. As far as our present knowledge goes, the morphology of

*Trypanosoma dimorphon*, *Trypanosoma congolense*, the Uganda, Zanzibar, Chai-Chai, Zambesi, Zululand, and Rhodesian strains is identical; these trypanosomes affect the same important domestic animals; the carrier is probably or may be the same, though this is not known, and therefore these various forms should, for the present, be grouped under one name; and for certain reasons given above we propose the name *Trypanosoma pecorum* for this group.

*Disease set up in Cattle by Trypanosoma pecorum.*

It is unnecessary in this paper to describe in detail the symptoms which can be noted during life, or the pathological changes set up in the organs of cattle by this trypanosome. It will be sufficient to say that the main symptoms are emaciation, anaemia, and progressive weakness, and that the principal *post-mortem* appearances are those due to anaemia.

*Incubation*.—As is probably true of most trypanosome diseases in susceptible animals, the period of time which elapses between the infection of the animal and the appearance of the trypanosomes in sufficient numbers in the peripheral blood to be seen by the microscope, is a short one: in this case, an average of 6·7 days.

*Duration*.—Of the course and duration of this disease in cattle little, unfortunately, is known. Most of the cattle which came under observation at the laboratory of the Commission at Mpumu were already sick when they arrived, and it was, as a rule, impossible to know when they had been infected. By referring to the table it will be seen that 22 naturally-infected cattle were under observation. Four of them lived, on an average, nine months. Of these four, one, treated with arsenic, was still alive and apparently healthy in December, 1909, one was killed, one had been treated with lithium antimonyl tartrate, and one died without treatment at the end of 313 days. It is therefore impossible to say from the insufficient data at our disposal whether spontaneous cure ever takes place in this disease in cattle.

When we turn to the cases of cattle which were inoculated on the hill, and were therefore under observation from the beginning, we are struck by the rapid course of the disease. One animal certainly lived 287 days, but the remainder died, on an average, in 26 days from the date of infection. Most of these oxen were inoculated with a strain of this trypanosome which had caused a rapidly fatal epidemic among a herd of milch cattle belonging to Mr. Walsh, at Kabula Muliro. In the short space of one month 24 of Mr. Walsh's cattle died, and in two months 34 had died out of a herd of about 300 head.

It may therefore be concluded that *Trypanosoma pecorum* sets up a rapid and fatal disease in cattle.

*Disease set up in Goats and Sheep by Trypanosoma pecorum.*

The number of cases of this disease in goats and sheep which came under observation is too small to draw any conclusions from. At Mpumu the goats and sheep were not satisfactory experimental animals, as many of them died from some unknown cause. It was thought that as these animals usually lived in the valleys, and were often housed in their owner's hut during the night, the exposure on the top of the hill had a bad influence. One sheep was still alive after 168 days, and it is probable that most of the goats and sheep would have lived much longer if they had been kept under more favourable conditions.

*Disease set up in the Smaller Laboratory Animals.*

It is not necessary to describe in detail the action of *Trypanosoma pecorum* on the monkey, dog, and smaller laboratory animals, as a reference to the table will show the average periods of incubation and duration. It will be seen that this is a fairly rapid and fatal disease in the dog, white rat, and mouse. In the monkey the average duration is about two and a-half months.

THE CARRIER OF TRYpanosoma PECORUM.

*Glossinæ*.—From experiments made in the laboratory at Mpumu it seems probable that *Glossina palpalis* is capable of acting as a carrier of this trypanosome. Four experiments were made with ordinary wild Lake-shore flies, and of these one was successful. Four were also made with laboratory-bred flies, and one again came off. The latter experiment, however, with laboratory-bred flies was not free from doubt; but from the other, which seemed free from doubt, it appears that *Trypanosoma pecorum* can develop in *Glossina palpalis* and infect a healthy animal after a period of 21 days. More observations are required. It may be noted that in no instance did *Trypanosoma pecorum* appear in the blood of animals upon which freshly-caught Lake-shore tsetse flies had been fed. These flies were found to be naturally infected with *Trypanosoma gambiense* and *Trypanosoma vivax*. This is an argument, though a small one, that *Glossina palpalis* is not the common or chief carrier of *Trypanosoma pecorum*.

*Tabanidae*.—There is some circumstantial evidence available to show that *Trypanosoma pecorum* is carried by the *Tabanidae*. In the valleys round Mpumu Hill, so far as we are aware, there are no tsetse flies at any time of

the year. As a rule, there are a few *Tabanidae*. The cattle belonging to the Commission went down to the foot of the hill every morning to graze, and returned to their kraal on the top at sunset. Half of the herd went to the east of the hill and half to the west. On both sides there was a small valley or glen, through which ran a small stream. In these valleys during the year, as a rule, a *Tabanus* or two or a *Hæmatopota* could be seen, but they were in small numbers. Now it is a curious fact that at certain times of the year enormous numbers of *Tabanidae* will suddenly appear in places where only a few are, as a rule, to be found. For example, Mr. Brown, at Mabira, who was collecting the biting flies of his district, wrote on March 14, 1909, that the *Tabanidae*, which for months had been scarce, were then swarming everywhere in countless numbers, and he afterwards wrote that this invasion lasted about a month. The particular species which appeared at Mabira at this time was *Tabanus socialis* (Walk.).

So, in the same way, at Mpumu, the *Tabanidae*, which had been rare, suddenly appeared in swarms. They were first seen in the valley to the west of the hill in September, 1909, and a month later in the valley to the east. Soon after this the cattle which had shown no signs of disease during the previous year were found to be suffering from *Trypanosoma pecorum*. Those which grazed in the valley to the west were the first to be affected, and afterwards those which grazed to the east of the hill. The species of *Tabanidae* in this case was *Tabanus secedens* (Walk.). In both groups of cattle there were cases of *Trypanosoma pecorum* disease, so that the *Tabanidae* had a reservoir from which to draw the virus.

Another sudden epidemic of *Trypanosoma pecorum* disease occurred on Mr. Walsh's farm at Kabula Muliro, where, as stated above, 34 milch cattle died within two months in a herd of 300. The evidence is all against this epidemic having been caused by tsetse flies. During February and March, and again later in the year, during August and September, as many as 100 fly-boys were engaged scouring this district for biting flies. *Tabanidae*, *Hæmatopota*, and *Chrysops* were brought in, but not a single tsetse, although a reward of 5 rupees was offered for each specimen. The commonest *Tabanus* in this district during August was *varietus* (Walk.).

It may, therefore, in our opinion, be concluded that the trypanosome disease caused by *Trypanosoma pecorum* can be carried from sick to healthy animals without the aid of *Glossinæ*, but what other species of fly, if any, acts as carrier is merely a matter of speculation at present.

*Stomoxys*.—Montgomery and Kinghorn state that they have strong evidence against this genus. At Mpumu several experiments were made to attempt to settle this question, but although they were persevered in for

months, they remained negative. *Stomoxyx* are so numerous in every part of the country all the year round that it seems inconceivable that they can act as carriers. From October, 1908, until the following September, although numerous cases of cattle with *Trypanosoma pecorum* in their blood grazed all day long with healthy cattle, yet not a single case of infection took place. The *Stomoxyx* were exceedingly numerous all this time, forming a small cloud of flies round the cattle, and passing constantly from one animal to another, being driven hither and thither by the rapidly-swishing tails. This is a natural experiment on a large scale.

It will therefore require very convincing proof to bring this Commission to the belief that *Stomoxyx* are carriers of this disease.

The subject of the carrier of *Trypanosoma pecorum* must remain in this unsatisfactory state for the present, but it is hoped that experiments which are at present being carried out at Mpumu may throw some light on this important part of the subject.

#### CULTIVATION OF TRYPANOSOMA PECORUM.

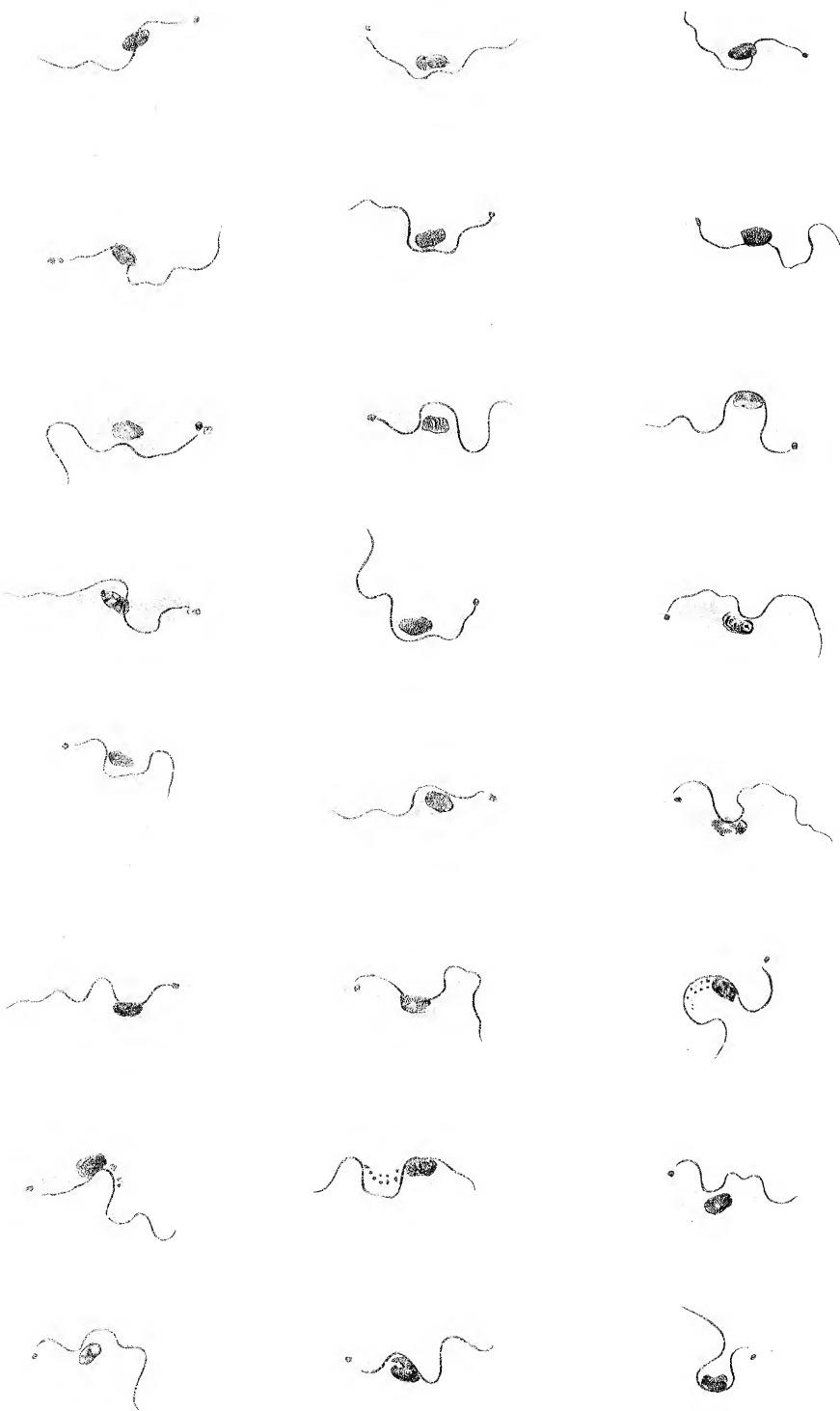
One difficulty experienced at Mpumu in attempts to cultivate the various trypanosomes was that rabbits were not available to supply the blood for Novy and MacNeal's medium. The blood of rats, goats, and oxen was used; but in making the cultivation of trypanosomes a factor in their diagnosis uniformity must be of the first importance.

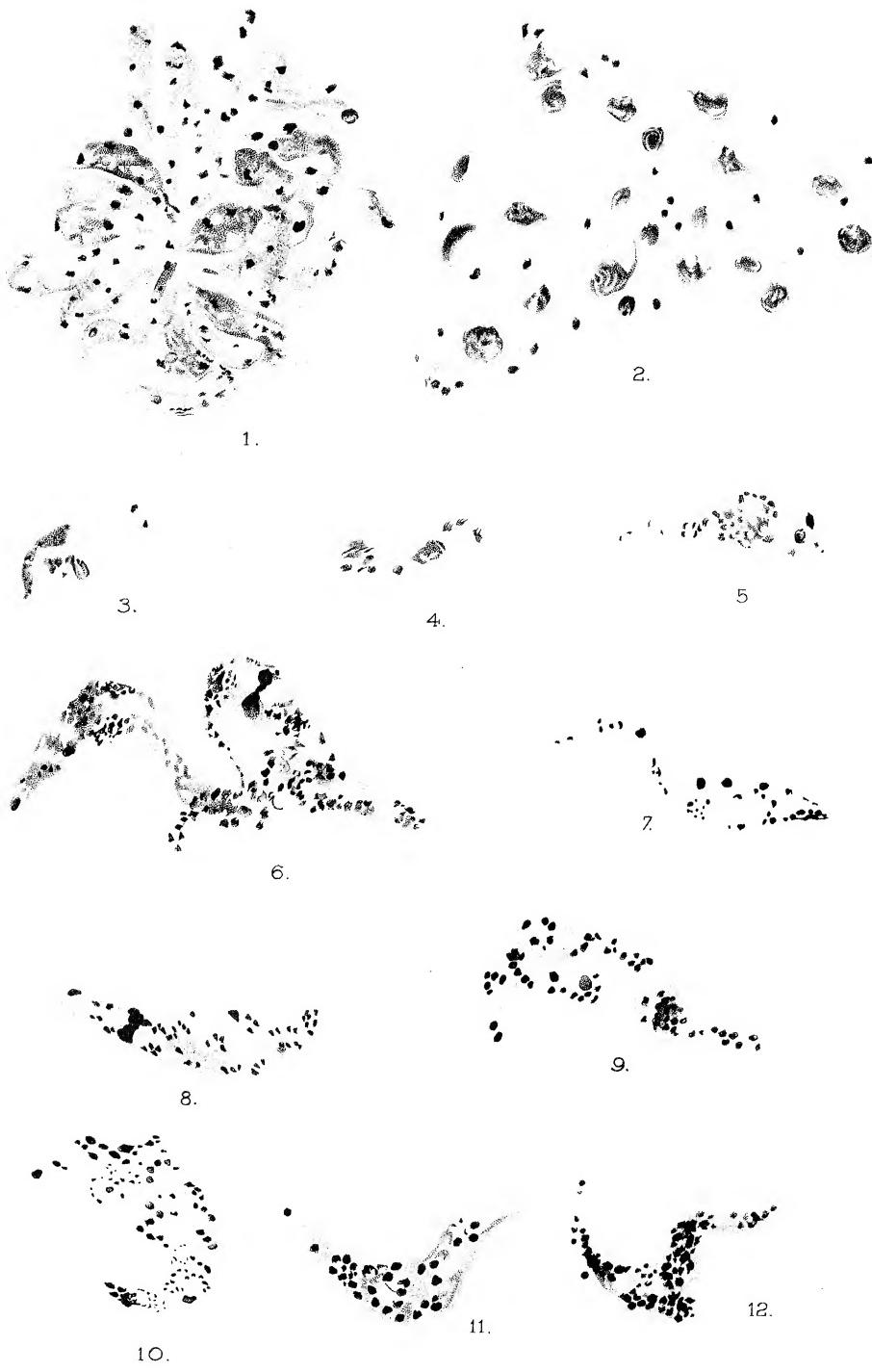
Another difficulty was the frequency of contamination of the tubes. This was, perhaps, to be expected in a laboratory on the top of a hill in the tropics, with very free ventilation.

*Trypanosoma pecorum* grows fairly readily on blood-agar medium. At the end of 24 hours clumps may be seen containing many trypanosomes, with their flagellar ends directed outwards and in active motion (Plate 12, fig. 1). The individual flagellates have irregularly-shaped granules of chromatin scattered through their body substance, and also many brightly-refractile vacuoles. After 48 hours' culture every field contains many active trypanosomes, and also small clumps composed of 10, 20, or more members (Plate 12, fig. 2).

After six days the trypanosomes are still very active; they vary much in size and shape, from the plasmodial to the elongated, flagellated, highly active trypanosome. After this they seem to degenerate, and in a few days living trypanosomes can no longer be found in the tube.

This description approaches to some extent that of the cultural characters of Dr. Edington's trypanosome from Zanzibar and *Trypanosoma dimorphon*, but there is not that extraordinary growth which was described as covering





several fields of the microscope. Whether this was due to the difference in the composition of the blood medium, or to the higher temperature at Mpumu, it is impossible at present to say.

By comparing the coloured plates of this trypanosome and the one from Zanzibar, a certain resemblance will be seen, but how far this should be taken as a factor in the diagnosis is difficult to say.

#### CONCLUSIONS.

1. *Trypanosoma pecorum* is an important trypanosome disease of domestic animals in Uganda.
2. It is similar in morphology, action on animals, and cultural characters, to the *Trypanosoma dimorphon* described by Laveran and Mesnil, and to Dr. Edington's trypanosome from Zanzibar, described in the 'Proceedings,'\* except that *Trypanosoma pecorum* is not pathogenic to guinea-pigs.
3. The carrier is unknown, but is probably a *Tabanus*, and not *Stomoxys*.

#### DESCRIPTION OF PLATES.

##### PLATE 11.

This plate represents the general appearance of *Trypanosoma pecorum* in stained preparations. Note the rounded, blunt, or angular shape of the posterior extremity; the small, round micronucleus and vacuole placed near this end; the oval nucleus; and the absence of a free flagellum, except in dividing forms. Stained Giemsa,  $\times 2000$ .

##### PLATE 12.

Fig. 1.—An aggregation, or clump, of *Trypanosoma pecorum* after 24 hours' growth in blood-agar. Stained Giemsa,  $\times 2000$ .

Fig. 2.—The same after 48 hours. Stained Giemsa,  $\times 2000$ .

Figs. 3, 4, and 5.—*Trypanosoma pecorum* after 3 days' growth. Stained Giemsa,  $\times 2000$ .

Figs. 6 and 7.—*Trypanosoma pecorum* after 4 days' growth. Stained Giemsa,  $\times 2000$ .

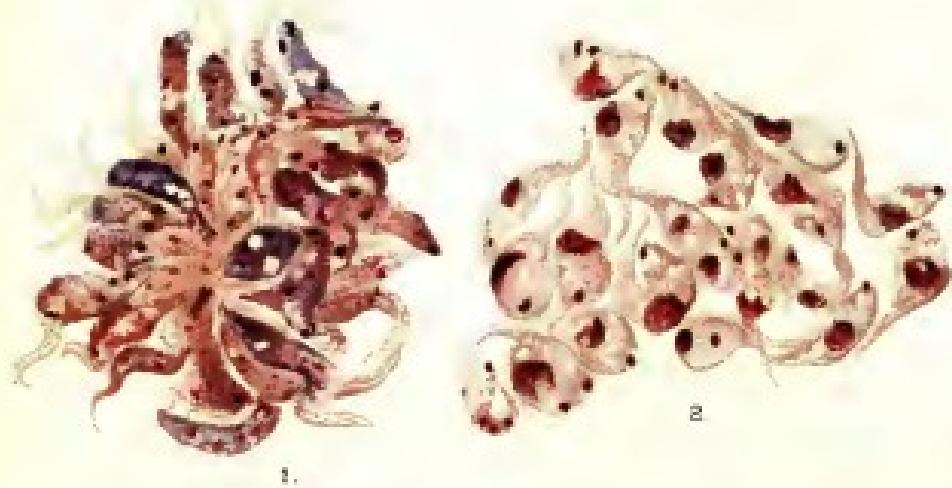
Figs. 8 and 9.—*Trypanosoma pecorum* after 8 days' growth. Stained Giemsa,  $\times 2000$ .

Figs. 10, 11, and 12.—*Trypanosoma pecorum* after 10 days' growth. Stained Giemsa  $\times 2000$ .

\* B, vol. 81, p. 14.

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9.



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11.



12.